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Bumble Bees Collected by the California Academy—Lingnan Dawn-Redwood Expedition to Central West China, 1948

(Hymenoptera: Apidae)

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The present paper is a report on the taxonomic study of the bumble bees collected by the California Academy—Lingnan Dawn-redwood Expedition to Central West China (1948), or more familiarly known as the *Metasequoia* Expedition. The main purpose of the expedition was “to collect insects and other animals in the hope of finding some ancient faunal elements of possible North American affinity which might have survived with *Metasequoia* and the other ancient trees associated with it” (Gressitt, 1953). Bumble bees are not suitable material to trace such a relation, yet the collected specimens are valuable because of insufficient information on this group in Eastern Asia. Numerous names have been published for the Chinese bumble bees (Wu, 1941), and a zoogeographical consideration was given by Panfilov (1957). Most descriptions of Chinese forms published prior to 1940 were incomplete. The resulting misinterpretations of taxa were serious for any further studies on this difficult group. Only recently various “forms” are being restudied accurately by the examination of type specimens (Tkalců, 1960, 1961a,b, 1968a,b). For the time being, however, we need more effort to clarify each taxon inhabiting this vast area. For this purpose, the present study may serve as a milestone for future synthesis.

Except for a few specimens collected in 1950 from Luichow Peninsula, Kwangtung Prov. by Dr. J. L. Gressitt, most specimens were collected by him and Mr. Y. W. Djon during July to September 1948 from the localities as shown in Fig. 1. The map is based upon a sketch prepared by Dr. Gressitt.

The subgeneric system mainly follows that by Richards (1968). The synonymic lists include only the original description and important papers.

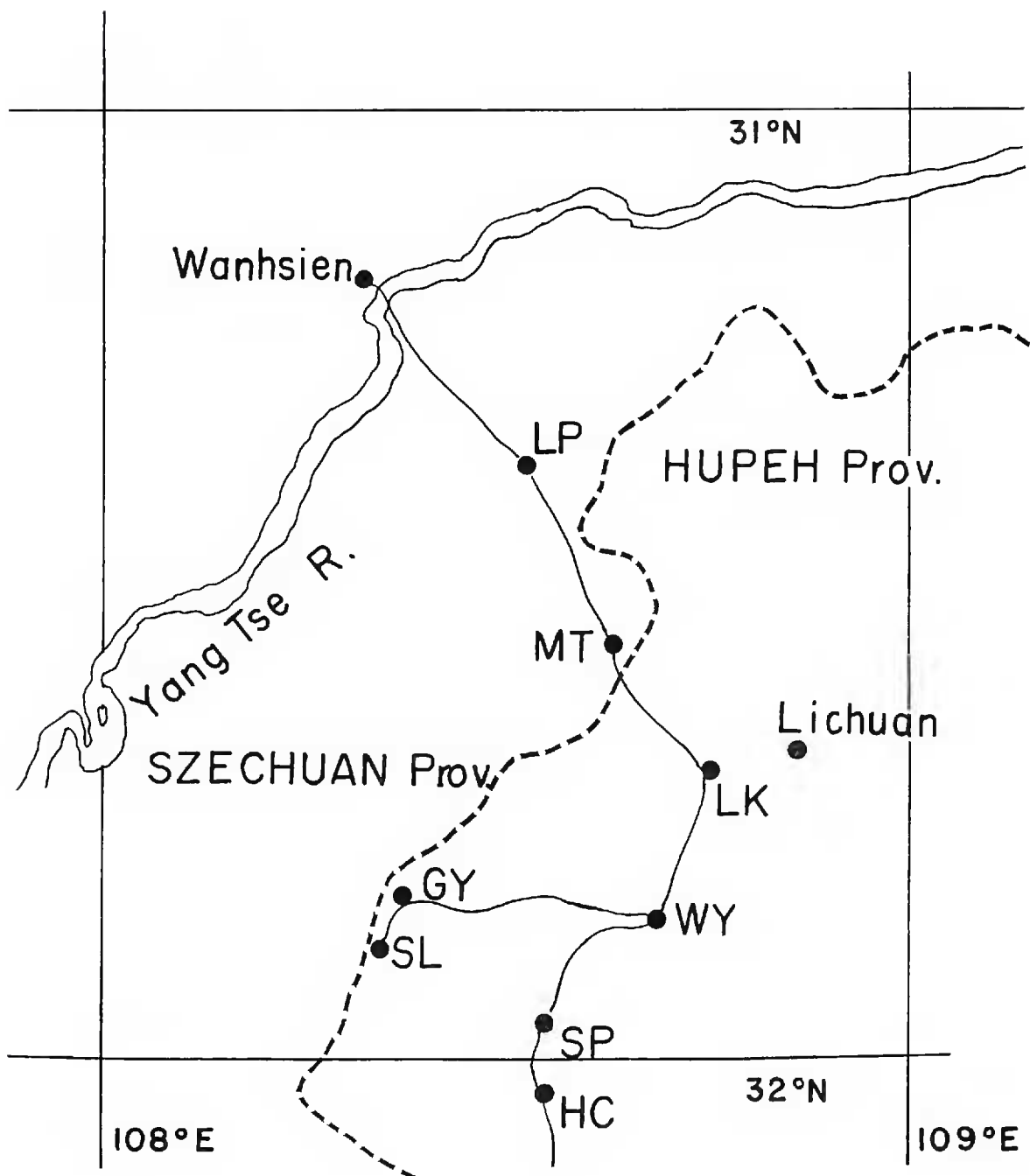


FIG. 1. Map showing localities where the specimens were collected. Hupeh Province (Lichuan District): Sui-hsa-pa (= Suisapa, 1,000 m, SP), Hsiao-ho (= Hsiacho, HC), Wang-chia-ying (Wang-ga-ying, WY), Gan-yu-yai (GY), Song-lung-chi (SL), Leung-ho-keo (Leung-ho-kow, LK), Szechuan Province (Wanh sien District): Mo-tau-chi (MT), Lung-chiu-pa (Luncheпа, LP).

Before going further, I would like to express my heartiest thanks to Dr. Paul H. Arnaud, Jr. and Mr. Hugh B. Leech, California Academy of Sciences, San Francisco, and Dr. Yoshihiro Hirashima, Kyushu University, Fukuoka, who gave me the opportunity to study valuable materials, Dr. J. L. Gressitt, Bernice P. Bishop Museum, Honolulu, who informed me through Mr. Leech of details about the localities where the specimens were collected, and Dr. Robbin W. Thorp, University of California, Davis, who read the manuscript

and helped me publish it. My sincere gratitude is also expressed to Dr. Borěk Tkalců, Praha, whose expert knowledge based upon examinations of many type specimens and whose unselfish answers to my questions were indispensable to complete the work.

BOMBUS (TRICORNIBOMBUS) ATRIPES Smith

Bombus atripes Smith, 1852: 44, ♀, ♂.

Megabombus (Tricornibombus) atripes, Tkalců, 1968b: 83, ♀, ♀, ♂.

SPECIMENS EXAMINED.—WY, 22–23 September, 3 ♀; SL-GY-WY, 19 September, 2 ♀, 1 ♂.

Recently this and the next species were thoroughly redescribed by Tkalců (1968b). The hair coat coloration, bright orange brown above, blackish below, is constant for all specimens examined.

BOMBUS (TRICORNIBOMBUS) IMITATOR Pittioni

Bombus (Tricornibombus) imitator Pittioni, 1949: 251, ♀.

B. (T.) imitator var. *flavescens* Pittioni, 1949: 254, ♀.

Megabombus (Tricornibombus) imitator, Tkalců, 1968b: 90, ♀, ♀, ♂.

SPECIMENS EXAMINED.—SP, 26 July, 2 ♀, 2–3 August, 2 ♀, 16 August, 1 ♀, 1 ♂, 22–30 August, 11 ♀, 1 ♂, 12–17 September, 8 ♀, 3 ♂; HC, August, 1 ♀; LK, August, 1 ♀, 31 August, 2 ♂, 7 September, 1 ♀, 9 September, 1 ♂.

These specimens were seemingly already examined by Tkalců (cf. Tkalců, 1968b, p.93). In most specimens the apical half of metasomal tergum III bears pale ochre orange hairs, occasionally black hairs are confined to the anterior lateral corners (= *flavescens* Pittioni, cf. also Tkalců, 1968b). Terga III and IV of one male are tawny yellow orange with sparse admixture of black hairs anteriorly. Black interalaris of most specimens is poorly defined, and in small workers often represented by an obscure dark patch.

BOMBUS (THORACOBOMBUS) OPULENTUS Smith

Bombus opulentus Smith, 1861: 153, ♀.

Megabombus (Agrobombus) opulentus, Tkalců, 1968a: brief note.

SPECIMENS EXAMINED:—WY, 23 September, 1 ♀, 22 September, 1 ♂; GY-WY, 20 September, 1 ♂.

The identification of these specimens as *B. opulentus*, a long forgotten taxon, was based upon a brief note by Tkalců given in the description of *Bombus honshuensis* (Tkalců) and confirmed by himself (*in litt.*). Because Dr. Tkalců is preparing the descriptions of three castes of this species, only some remarks on hair color and some male characters are given here.

HAIR COLOR.—*Worker*.—Mesosomal disc, upper half of mesosomal side and metasomal terga I ~ II orange brown. Head excluding sparse orange brown

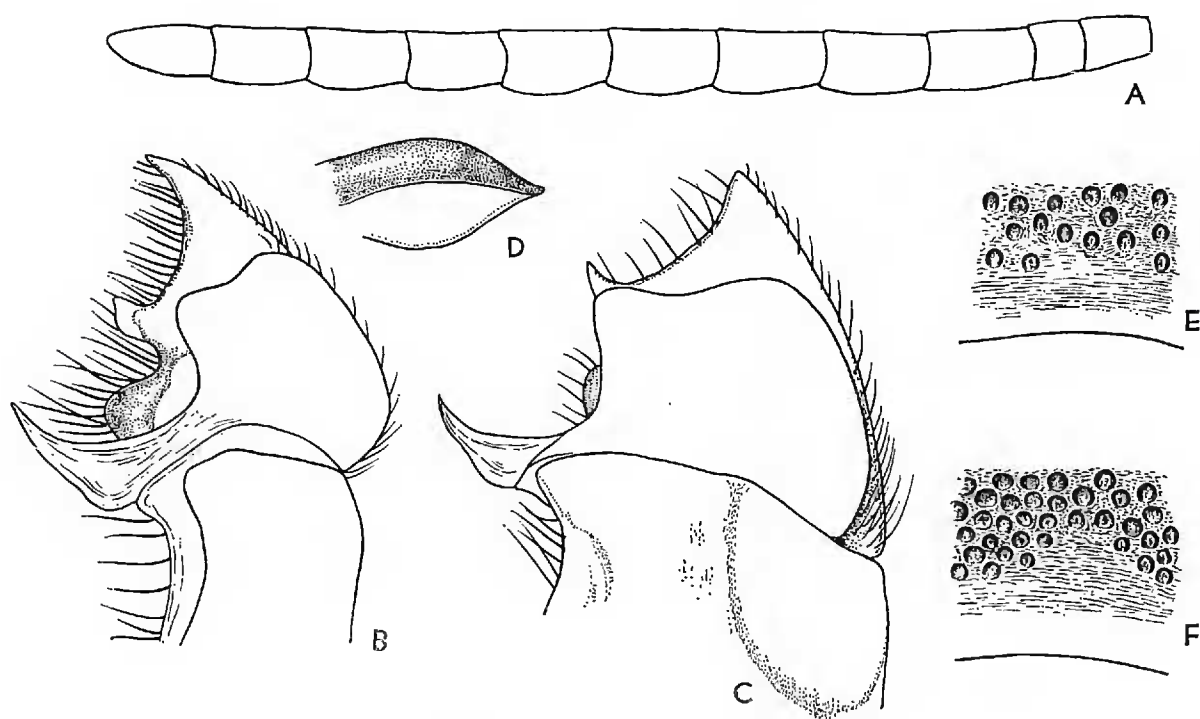


FIG. 2. Comparison of males of *B. opulentus* (A ~ D, F) and *B. schrencki* (E). A. Antenna; B. Apex of genitalia dorsal view; C. Same dorsolateral view; D. Lower membrane of basal process of gonostylus; E and F. Sculpture of posterior part of metasomal tergum IV.

hairs on vertex, lower half of mesosoma, terga IV ~ VI, sterna and legs blackish to chocolate brown, tergum II laterally broadly blackish. *Male*.—Generally as worker but differing in following points: Short plumose hairs on face and gena pale fulvous; vertex mostly pale orange brown with sparse black hairs; lower half of mesosoma with more extensive orange brown hairs, leaving narrow dark chocolate band on venter; coxae and trochanters below with pale brownish hairs; hairs of tergum II entirely orange brown, slightly paler apically, forming obscure marginal ciliation; hairs of tergum III entirely blackish in one specimen, basal half blackish and apically orange brown in another, both with obscure ciliation; sterna with obscure marginal ciliation.

MALE CHARACTERS.—(cf. Synoptic table of *B. unicolor* (Fries) = *U*, *B. schrencki* (Morawitz) = *S* and *B. honshuensis* = *H* in Tkalcû 1968a, p.48) : 1) Flagellar segments IV ~ X moderately swollen below (Fig. 2 A, = *U*, ≠ *S*, *H*). 2) Punctures bearing hairs on hind tibia dense and homogenous (= *S*, *U*, ≠ *H*). 3) Forewing darker than in *S*. and *U*, with slight iridescence. 4) Penis valve below with short rectangular denticule (= *U*, *S*, ≠ *H*). 5) Lateral depression of gonocoxite basally not distinctly demarcated (Fig. 2 C, = *U*, *S*, ≠ *H*). 6) Apical contour of gonostylus similar to that of *U*, inner angle slightly more pointed though not so conspicuously as in *S* (Fig. 2 B, C). 7) Lower membrane of inner process of gonostylus as in *S* (Fig. 2 D). 8) Basal process of lacinia dorsolaterally well visible (Fig. 2 C, = *S*, *H*). 9) Barba mandibularis honey yellow (= *U*, *H*, ≠ *S*). 10) Erect hairs of scape blackish brown (= *U*, *S*, ≠ *H*).

Thus, *B. opulentus* is more closely related to *B. schrencki* and *B. unicolor* than to *B. honshuensis*. Besides the characters noted above, the punctures on tergum IV, especially marginally, are better defined

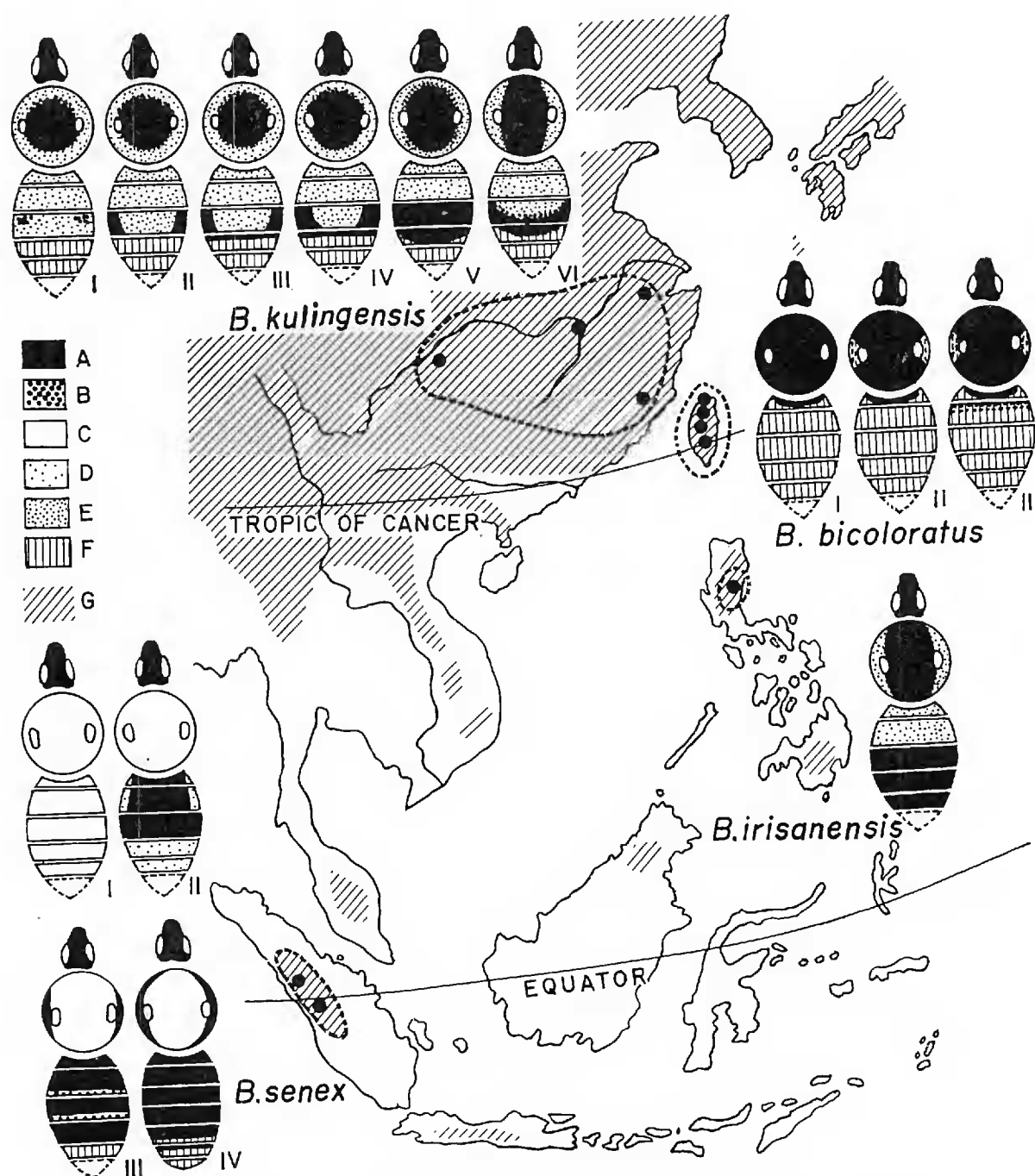


FIG. 3. Distribution and color patterns of the four species of the subgenus *Senexibombus* Frison. All color patterns shown are of females, except *B. senex* f. *pallidithorax* (IV) known by male only. *Bombus kulingensis* Cockerell (Central West China) I. Typical form, II. "tajushanensis" Pittioni, III. *k.* f. *quasiflavior* Tkalcu and "t." f. *flavior* Pittioni, IV. "t." f. *nigrofasciatus* Pittioni, V and VI a worker and queen described in text; *B. bicoloratus* Smith (Formosa) I. Typical form, II. f. *fulvolateralis* Cockerell, III. f. *intermedius* Chiu; *B. irisanensis* (Philippines, in variation recorded); *B. senex* Vollenhoven (Sumatra) I. Typical form, II. f. *sumatrensis* Cockerell, III. f. *ardentior* Cockerell, IV. f. *pallidithorax* (Frison) (♂). Color codes: A. Black, B. Admixture of blackish hairs, C. Whitish, D~E. Pale to deep yellowish or ochraceous, F. ferruginous. G. Distribution of bumble bees in E. and SE. Asia.

and denser in *B. opulentus* than in *B. schrencki* (Fig. 2E, F). Certainly *B. opulentus* may be regarded as the Southernmost representative of the *B. schrencki*-group.

BOMBUS (SENEXIBOMBUS) KULINGENSIS Cockerell

Bombus kulingensis Cockerell, 1917: 266, ♀.

Bombus (*Senexibombus*) *tajushanensis* Pittioni, 1949: 244, ♀, ♂; f. *nigrofasciatus*, 246, ♀, ♂; f. *flavior*, 247, ♀, ♂.

Bombus (*Senexibombus*) *kulingensis*, Tkalčů, 1961a: 46, ♀; f. *quasiflavior*, 52, ♀.

SPECIMENS EXAMINED.—SP, 26 August, 1♂ (in very poor condition), 27 August, 1♀, 29 August, 1♂.

By the synoptic table of *B. tajushanensis* and *B. kulingensis* by Tkalčů (1961a), the specimens examined straightly go to the latter. But Dr. Tkalčů recently informed me that *B. kulingensis* and *B. tajushanensis* are conspecific. Two specimens examined are characterized by their melanism, a queen without pale hairs on mesosomal dorsum, and a worker with tergum III completely, IV nearly entirely black. Figure 3 shows the distribution and color patterns of the four species forming *Senexibombus*, a small subgenus endemic to Eastern and Southeastern Asia at the S.E. Asiatic boundary of bumble bee distribution. The record of *B. kulingensis* from Western Hupeh represents, for the time being, the northwestern limit of the subgenus.

BOMBUS (DIVERSOBOMBUS) TRIFASCIATUS Smith

Bombus trifasciatus Smith, 1852: 43, ♀, ♂.

Bombus ningpoensis Friese, 1909: 675, ♀ (cf. Tkalčů, 1961b, 367).

Bombus (*Diversobombus*) *ningpoensis*, Pittioni, 1949: 251, ♀, ♂; Tkalčů, 1960: 4, ♂.

Bombus (*Diversobombus*) *ningpoensis* subsp. *minshanicus* Bischoff, 1936: 19, ♂.

SPECIMENS EXAMINED.—SP, 22–31 July, 23♀, 1–10 August, 22♀, 11–20 August, 68♀, 1♂, 21–31 August, 77♀, 1–10 September, 1♀, 2♂, 11–18 September, 20♀, 1♂; LK, 12 August, 1♀, 28–31 August, 5♀, 1–10 September, 87♀, 1♂; LK-SP, 21 August, 1♀, 18 September, 2♂; HC, 4 August, 1♀, 12–16 August, 8♀; WY-SP, 21 July, 1♀; WY, 22 September, 2♀; SL-GY-WY, 19 September, 3♀; LP, 29 September, 1♀; MT, 25–26 September, 4♀; Kwangtung Prov., Luichow Peninsula, 8 September, 1♀.

This is apparently one of the most abundant and widespread bumble bee species in Western China. Some structural differences from *B. diversus* Smith, the type species of the subgenus, are as follows: 1) Punctures on ocellular area above (♀, ♂) more well defined, contrasting with interspaces smoother, showing less marked undulations

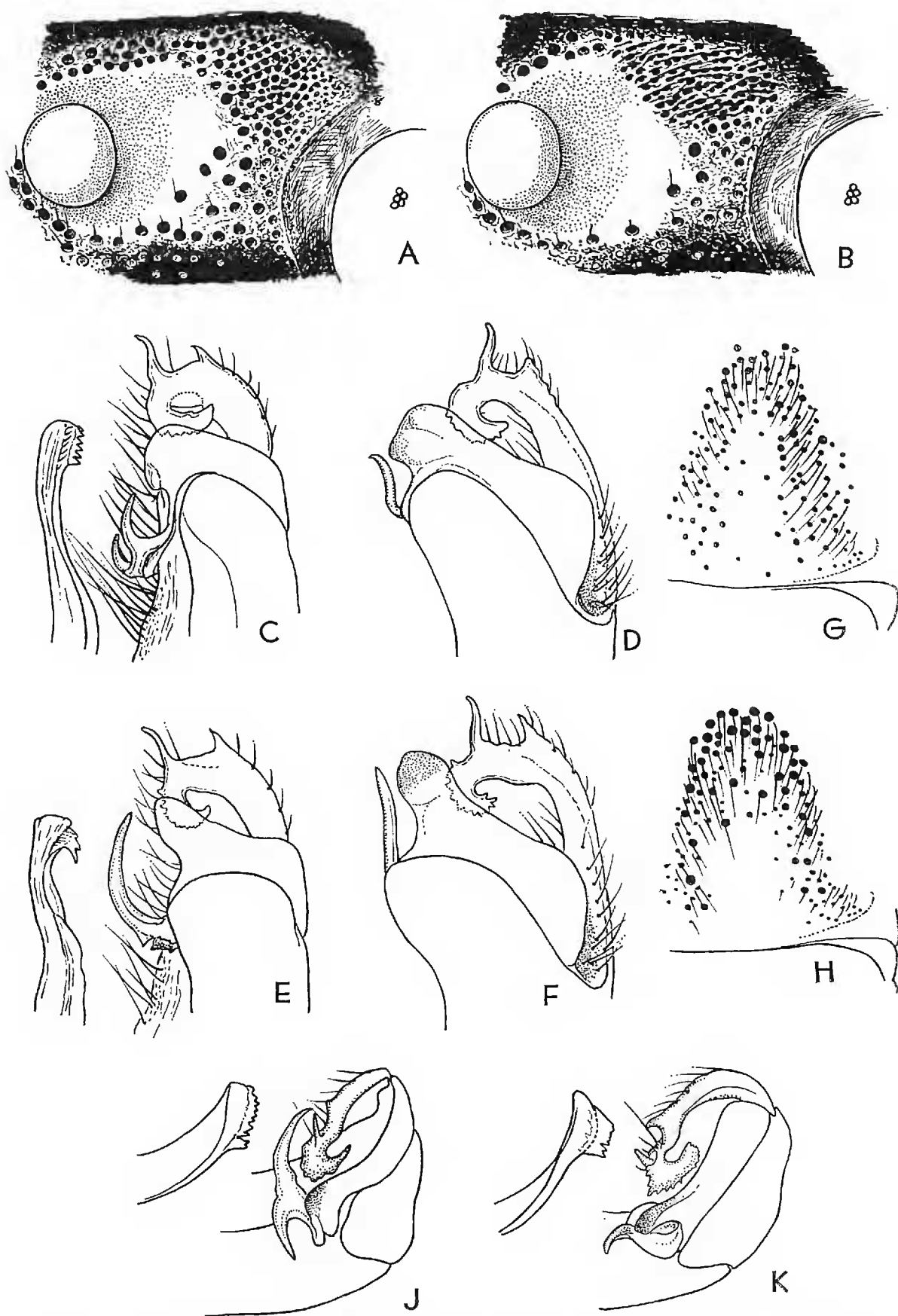


FIG. 4. Comparison of *B. trifasciatus* (A,C,D,G,J) and *B. diversus* (B,E,F,H,K). A,B. Sculpture on ocellocular area (worker); C,E. Apex of male genitalia, dorsal view; D,F. Same, dorsolateral view; J,K. Same, apical view; G,H. Punctuation of male clypeus.

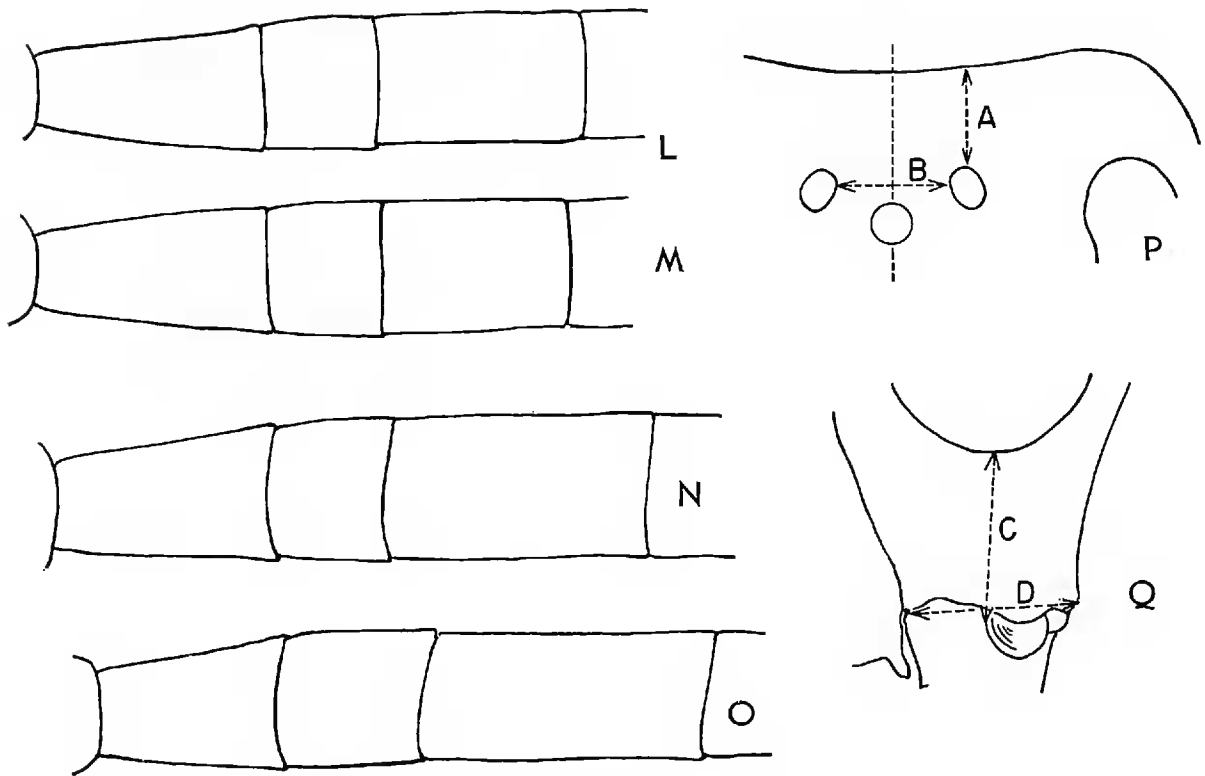


FIG. 5. Comparison of *B. trifasciatus* (M,N) and *B. diversus* (L,O), continued. L,M. Basal flagellar segments (worker) ; N, O. Ditto (males) ; P, Q. Parts used for relative size measurements (cf. in text).

(Fig. 4A, B). 2) Punctures on metasomal terga (♀, ♂), especially IV and V, denser, submarginally punctures often nearly as wide as interspaces. 3) Male clypeus with less coarse punctures and medio-apical smooth area less contrasting (Fig. 4G, H). 4) Male antennal flagellum I slightly longer and II slightly shorter (Fig. 5N, O). 5) Inner apex of male gonocoxite relatively well projecting (Fig. 4C-F, J, K). 6) Inner angle of male gonostylus more angulate apically (Fig. 4C-F, J, K). 7) Inner process of male gonostylus shorter and bifurcate (Fig. 4C, E, J, K). 8) Outward serration of head of penis valve less projecting but more continuous (Fig. 4C, E, J, K).

The shape of the inner process of the gonostylus is most critical. On this character, *B. diversus*, (Japan), *B. ussurensis* Radoszkowski (Japan, Korea, Ussuri) and *B. hummeli* Bischoff (North China, cf. Bischoff 1936, p. 19) form one group and *B. trifasciatus* another, together with *B. wilmani* Cockerell (Formosa), *B. montivagus* Smith (S.E. Asia, cf. Tkalců, 1968c), and *B. albidopleuralis* Friese (Nepal), suggesting the segregation of two species groups between northern and southern areas of the range of the subgenus *Diversobombus* endemic to East and S.E. Asia.

Using the rich material some variation studies were executed as

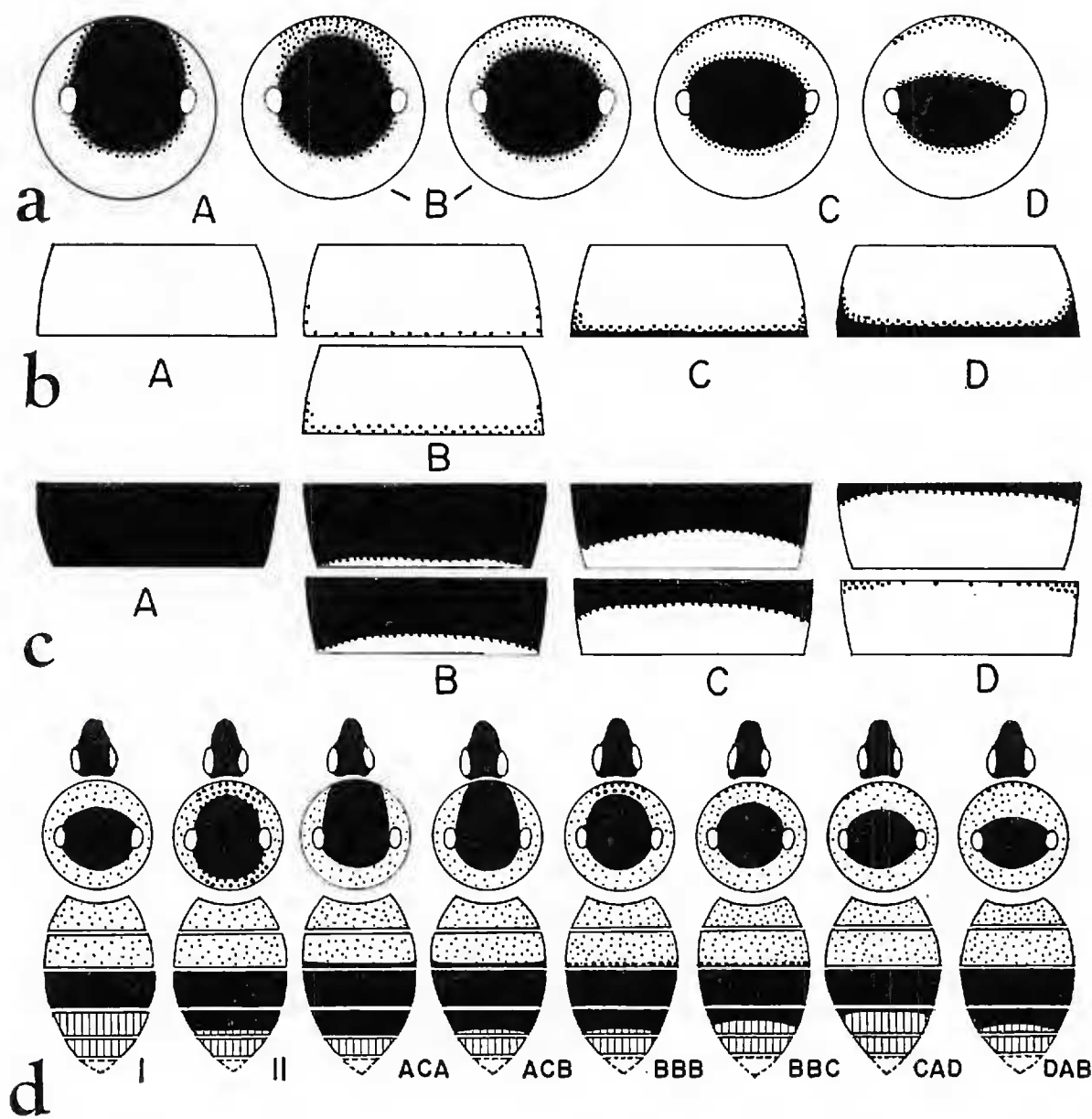



FIG. 6. Color variation in *B. trifasciatus*. a. Mesosomal dorsum; b,c. Metasomal terga II and IV; d. Selected color patterns, I. *trifasciatus* from original description; II. *f. minshanicus*; Others showing representative patterns described in text.

follows: HAIR COLOR.—The variation was studied with respect to the following three parts, which were most variable, of workers with relatively intact hair coat. 1) Mesosomal dorsum. Extent of black interalaris is variable. In most melanic specimens, pale collaris completely disappears. In the flavinic extreme, interalaris remains as a relatively narrow band (Fig. 6a, A–D). 2) Metasomal tergum II varies from completely yellowish to distinctly black banded posteriorly (Fig. 6b, A–D). 3) Tergum IV varies from completely black to nearly entirely ferruginous, leaving sparse black hairs anterolaterally (Fig. 6c, A–B).

The frequency distribution of various combinations of color patterns

(Fig. 3) is as follows: BBB 116, BBC 49, CBB 18, BBD 17, CBC 15, BCB 14, BAB 9, ABC, DBB each 7, ABB 6, BCC 5, BBA, BDB, CAB, CBD, ABD, DAC each 2, AAB, ABA, ABD, ACA, ACB, ACC, BAA, BAC, BAD, BCD, CAA, CAD, CBA, CDD, DAB, DBC each 1. For each body part, the frequency distribution is as follows: Mesosomal dorsum, A 20, B 222, C 43, D 11; tergum II, A 23, B 248, C 24, D 2; tergum IV, A 13, B 193, C 72, D 23, E 4. Pittioni (1949) referred to the relatively constant color pattern of this species with variability exhibited mostly in the extent of interalaris. The chromatic constancy of this species was also suggested by Tkalcû (1960). The population studied by me seems to be more variable, though not so obviously as to be called polytypic. The prevalence of type B in mesosomal dorsum corresponds to subsp. *minshanicus* described from S. Kansu, characterized by the extension of interalaris and resulting diminution of both collaris and scutellaris, together with the appearance of narrow reddish band at the posterior margin of tergum IV in some specimens. In the specimens examined the decrease of collaris often reaches the extreme (type A, complete absence, and the invasion of reddish hairs on tergum IV is often greater (more advanced), whereas the diminution of scutellaris was never observed. Apparently the population studied shows a tendency to subsp. *minshanicus*-type but it is open to the question whether the species is divided into more than one distinct subspecies within the range. A single worker from Luichow Peninsula, Kwangtung Prov. showed type ABB, and four males with intact coat respectively BBB, BAC, CAA and DBD.

The variability of mesosomal disc correlates to the body size as follows:

| Head width | (mm) |  | | | | | Total bees |
|---------------|------|-------------------------------------------------------------------------------------|---------------------|---------------------|---------------------|-------------|------------|
| | | 3.75 \geq | 3.81 \sim 3.94 | 4.00 \sim 4.13 | 4.18 \sim 4.32 | \geq 4.37 | |
| Color pattern | A | | 2 | 5 | 10 | 3 | 20 |
| | B | 15 | 40 | 71 | 79 | 17 | 222 |
| | C | 9 | 12 | 9 | 12 | 1 | 43 |
| | D | 3 | 1 | 3 | 4 | | 11 |

Melanism appears more frequently in larger specimens. No such correlation was detected for terga II and IV.

ALLOMETRIC TENDENCY.—Moure and Sakagami (1962) enumerated morphological differences between queen and worker bumble bees. Some of them, especially those of the head, are similar to the allometric tendency of other bees (cf. Sakagami and Moure, 1965). This

feature was studied by using the specimens of *B. trifasciatus*, with respect to malar index (length/width of malar space, cf. Fig. 5 Q, C/D) and occipital index (interocellar distance/ocelloccipital distance, cf. Fig. 5P, B/A). The result is given as follows:

| Head width (mm) | Malar index | Number of (specimens) measured | Occipital index | Number of (specimens) measured |
|--------------------|----------------|--------------------------------------|--------------------|--------------------------------------|
| 3.25 ~ 3.57 | 1.21 | (12) | 1.10 | (14) |
| 3.62 ~ 3.75 | 1.18 | (14) | 1.15 | (13) |
| 3.81 ~ 3.88 | 1.23 | (10) | 1.21 | (9) |
| 3.94 | 1.22 | (14) | 1.23 | (13) |
| 4.00 | 1.27 | (16) | 1.29 | (16) |
| 4.06 | 1.26 | (12) | 1.30 | (11) |
| 4.13 | 1.28 | (17) | 1.31 | (20) |
| 4.19 | 1.27 | (17) | 1.34 | (13) |
| 4.25 | 1.28 | (17) | 1.40 | (18) |
| 4.31 | 1.30 | (17) | 1.40 | (15) |
| 4.38 | 1.31 | (12) | 1.43 | (11) |
| 4.43 ~ 4.50 | 1.29 | (10) | 1.46 | (12) |

The gradual increase of the ratio is conspicuous for the occipital index and, though less remarkable, is also traced in the malar index. The latter is of particular importance because this index is often adopted as a useful distinctive character. This allometric tendency is more conspicuous when queens and small workers are compared. For instance, the ranges and means of ratios in *B. diversus tersatus* Smith, measured each in five queens and five dwarf workers are as follows:

| | Head width (mm) | Malar index | Occipital index |
|---------|--------------------|--------------------|--------------------|
| Queens | 4.87 ~ 5.13 (5.04) | 1.20 ~ 1.26 (1.24) | 1.55 ~ 1.66 (1.62) |
| Workers | 2.56 ~ 2.82 (2.66) | 0.95 ~ 1.16 (1.04) | 0.65 ~ 0.88 (0.79) |

BOMBUS (ALPIGENOBOMBUS) BREVICEPS CHANNICUS Gribodo

Bombus channicus Gribodo, 1891: 116, ♀, ♀.
Alpigenobombus breviceps channicus, Tkalcû, 1968c: 16, ♀, ♀, ♂.
SPECIMENS EXAMINED.—MT-LP, 28 September, 1♀; LP, 29 September, 1♀, 1♂.

Hind tibia and basitarsus are bright chestnut, not yellowish ochre as in *B. b. vicinus* (Tkalcû).

BOMBUS (BOMBUS) IGNITUS Smith

Bombus ignitus Smith, 1869: 207, ♀, Tkalcû, 1962: 17, ♀, ♂.
Bombus (Bombus) ignitus, Sakagami & Ishikawa, 1969: 185.
SPECIMENS EXAMINED.—GY-WY, 20 September, 1♀; SL-GY-WY, 19 September,

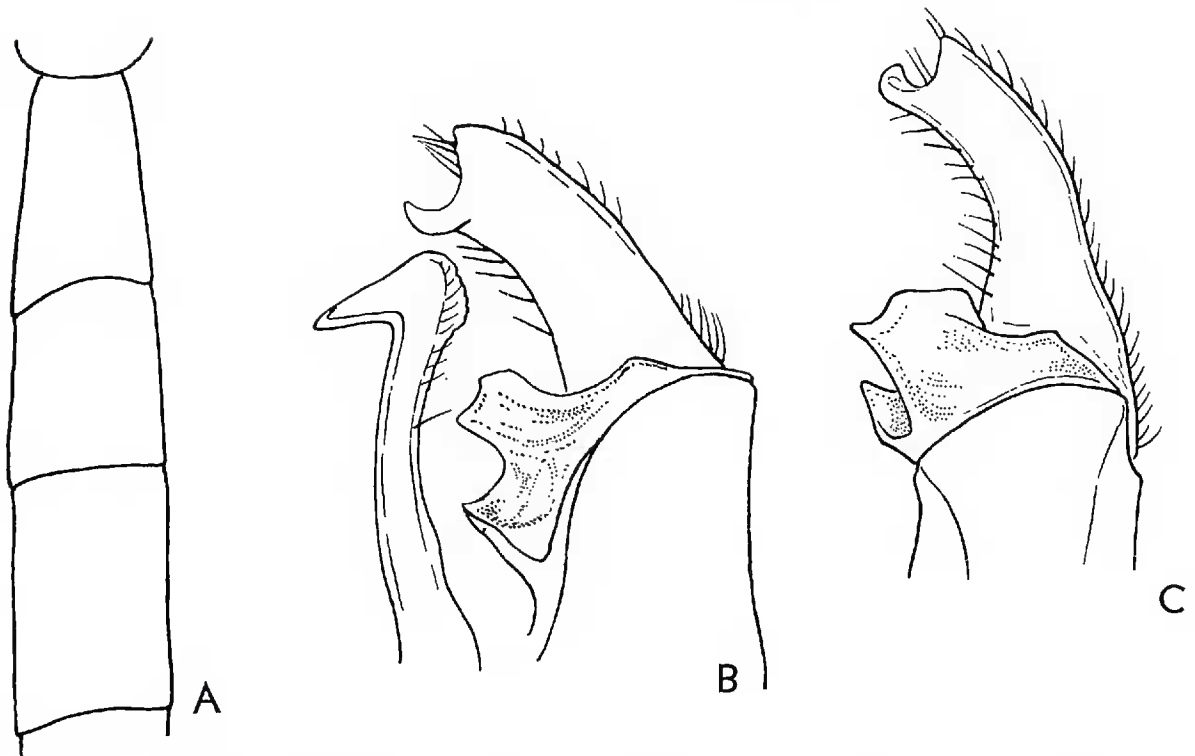


FIG. 7. *Bombus pyrosoma* (male). A. Basal flagellar segments; B and C. Apex of genitalia dorsal and dorsolateral views.

2♀; HC, 8–10 August, 2♀, 13–15 August, 3♀; LK, 9 September, 1♀; SP, 3 August, 3♀.

All specimens have sparse ochraceous hairs on metasomal tergum II (= var. *balteatus* Skorikov, 1933 or var. *cancellatus* Frison, 1935), and some specimens have similar hairs on tergum I, either anteriorly or posteriorly or mesosoma anteriorly (= var. *subcollaris* Skorikov, 1914).

BOMBUS (MELANOBOMBUS) PYROSOMA F. Morawitz

Bombus pyrosoma F. Morawitz, 1890: 349, ♀.

Bombus (*Lapidariobombus*) *pyrrhosoma pyrrhosoma*, Bischoff, 1936: 9, ♀, ♂, ♂.

Bombus (*Lapidariobombus*) *pyrrhosoma*, Tkalců, 1961b: 353, ♀.

SPECIMENS EXAMINED.—WY, 22 September, 1♀; LK, 7–9 September, 9♀; SP, 30 July, 6 August, 2♀; WY-SP, 21 July, 1♀; SL-GY-WY, 19 September, 1♀; MT, 26 September, 1♂; Kwangtung Prov., Luichow Peninsula, 8 September, 1♀.

The sculpture on ocellocular area agrees with the figure shown by Tkalců (1968a, Fig. 70). Male antenna and genitalia are illustrated in Fig. 7. The hair color of both sexes agrees with that given by Bischoff (1936):

WORKER.—Head, mesosoma and legs dark chocolate brown. Ill-defined collaris and scutellaris, coxa II below, trochanters, femora basally (to apex in femur III), tergum I, sterna whitish; other terga orange red (probably bright ferruginous when fresh). Mesosomal side below broadly whitish with admixture of dark hairs. Tergum I with sparse admixture of dark hairs.

Variation is seen in the degree of admixture of dark hairs to whitish parts, resulting in different contrasts of collaris, scutellaris and pleuralis though collaris is mostly separated from head by a narrow obscure dark band. A single worker from Luichow Peninsula possesses pleura nearly whitish with admixture of dark hairs only medially, otherwise not markedly differing from the other specimens, that is, not showing color pattern of *B. p. hönei* (Bischoff, 1936) and without structural difference from the other specimens.

MALE.—Head, mesosoma, legs and tergum I ochraceous yellow, other terga orange red. Sparse dark hairs on vertex, gena, face especially along eyes, and on interalar areas. Metasoma in poor condition, so that admixture of dark hairs not precisely examined. Mandibular beard blackish brown, partly with honey yellow hairs.

BOMBUS (PYROBOMBUS) FLAVESCENS Smith

Bombus flavescens Smith, 1852: 45, ♂.

Bombus (*Pratobombus*) *flavescens*, Pittioni, 1949: 259, ♀, ♂, ♂.

SPECIMENS EXAMINED.—HS, 9 August, 1 ♂.

A single specimen of this extremely polytypic species goes to *B. f. geei* Cockerell in the key by Pittioni.

HAIR COLOR.—Chocolate brown; tergum IV except anterior margin, and following terga, legs and sterna dirty orange yellow. Mandibular beard pale orange yellow, short hairs of face whitish to grayish yellow above antenna, more yellowish below, long facial hairs mostly dark, with admixture of yellowish hairs, clypeus with yellowish long hairs; small patches of fulvous hairs on terga I and II laterally and on tergum II medioposteriorly.

BOMBUS (PYROBOMBUS) FLAVUS Friese

Bombus pratorum ssp. *flavus* Friese, 1904: 517, ♂; Friese & v. Wagner 1909: 52, ♂.

Bombus parthenius var. *picipes* Richards, 1934: 90, ♀ (*Tkalců in litt.*).

Bombus (*Pratobombus*) *klapperichi* Pittioni, 1949: 266, ♀; f. *intermedius*: 268, ♀; f. *flavescentiformis*: 269, ♀.

SPECIMENS EXAMINED.—SP, 20–29 August, 7 ♀, 2 ♂, 17 September, 1 ♀; HS, 9–10 August, 2 ♀, 12–16 August, 6 ♀; LK, 31 August, 2 ♀, 4–10 September, 1 ♀, 5 ♀, 2 ♂; MT-LP, 28 September, 1 ♀; Kwangtung Prov., Luichow Peninsula, 8 September, 2 ♀.

The specimens examined were identified as *B. flavus*, a long forgotten taxon. The species is close to *B. modestus* Eversmann and *B. beaticola* (Tkalců). Three castes are redescribed below to avoid any further confusion.

ALL CASTES.—Integument black, hind tibia and all tarsi dark chestnut brown. Wings pale brown and hyaline, veins dark brown. Hair coat relatively long, erect and rather uneven.

QUEEN.—Body 16 mm, forewing 14 mm. *Hair color* (Fig. 10d, I).—Head dark to chocolate brown, with short hairs on face and sparsely on occiput fulvotestaceous. Interalaris broad and dark to blackish brown. Collaris virtually absent, represented only by sparse admixture of yellowish hairs. Scutellaris narrow but distinct, ochraceous yellow as mesosomal side. Metasomal tergum I entirely and anterior half of tergum II, broadly at middle, narrowly at side, ochraceous yellow, with sparse admixture of dark brown hairs; remainder of tergum II, III and anterior two thirds of IV blackish brown; tergum IV posteriorly, V, and sparse hairs on VI faded ochraceous orange. Sterna I ~ III marginally pale fulvous, IV ~ V as tergum V, all sterna with admixture of dark hairs, denser laterally. Legs dark brown, coxae, trochanters and femora basally below ochraceous yellow.

Structure.—Upper, maximum and lower interorbital distances, 36:46:42. Supraorbital punctures (Fig. 8M) 1.0 ~ 1.5 times larger than diameter of facets, slightly larger than, but essentially similar to those of *B. beaticola*, dense and rather irregular; interspaces weakly coriaceous and moderately shining, as wide as to two times wider than punctures; punctures on paraorbital corridor sparse, interspaces smooth and shining; postsupraorbital punctures dense, as large as or smaller than facets, interspaces average narrower than punctures, not becoming wider along postorbital margin; dorsal furrow distinct; suprafrontal punctures coarse and sparse, 2.0 ~ 2.5 times larger than facets. Relative measurements of vertex: Ocellocular distance 22, postocellar distance 25, ocelloccipital distance (cf. Fig. 5P) 25, distance between mid and lateral ocelli 6, diameters of mid and lateral ocelli 13, 12. Malar space nearly as long as wide, smooth except sparse, minute and ill-defined punctures on area slightly above mandibular base. Clypeus below with punctures slightly denser than in *B. beaticola* (Fig. 8E, F). Labrum as in *B. beaticola*; tubercles flat, shining but moderately coriaceous, with ill-defined punctures except coarser ones on lower slope; median furrow well depressed, granulate with fine and dense punctures; lamella distinctly curved, about one-third as wide as labrum. Mandible with basal punctures much denser than in *B. beaticola* (Fig. 8A–D), incisura lateralis distinct. Length : width ratios of flagellar segments : I (23:13.5), II (16:14), III (18:13.5), III slightly longer than in *B. beaticola* (III nearly $l = w$) (Fig. 9N, P). Median impunctate area of mesoscutum smooth and shining, maximum width about one-third distance between end of median line and posterior margin of sclerite. Metasomal terga finely tessellate but rather shining especially on IV and V, where punctures equal or slightly exceed size of facets, well defined and rather sparse with interspaces about 3 ~ 4 times puncture diameter except marginally where punctures denser and interspaces 2.0 ~ 3.5 times puncture diameter. Epipygium flat, granulate and weakly elevated, coriaceous with fine

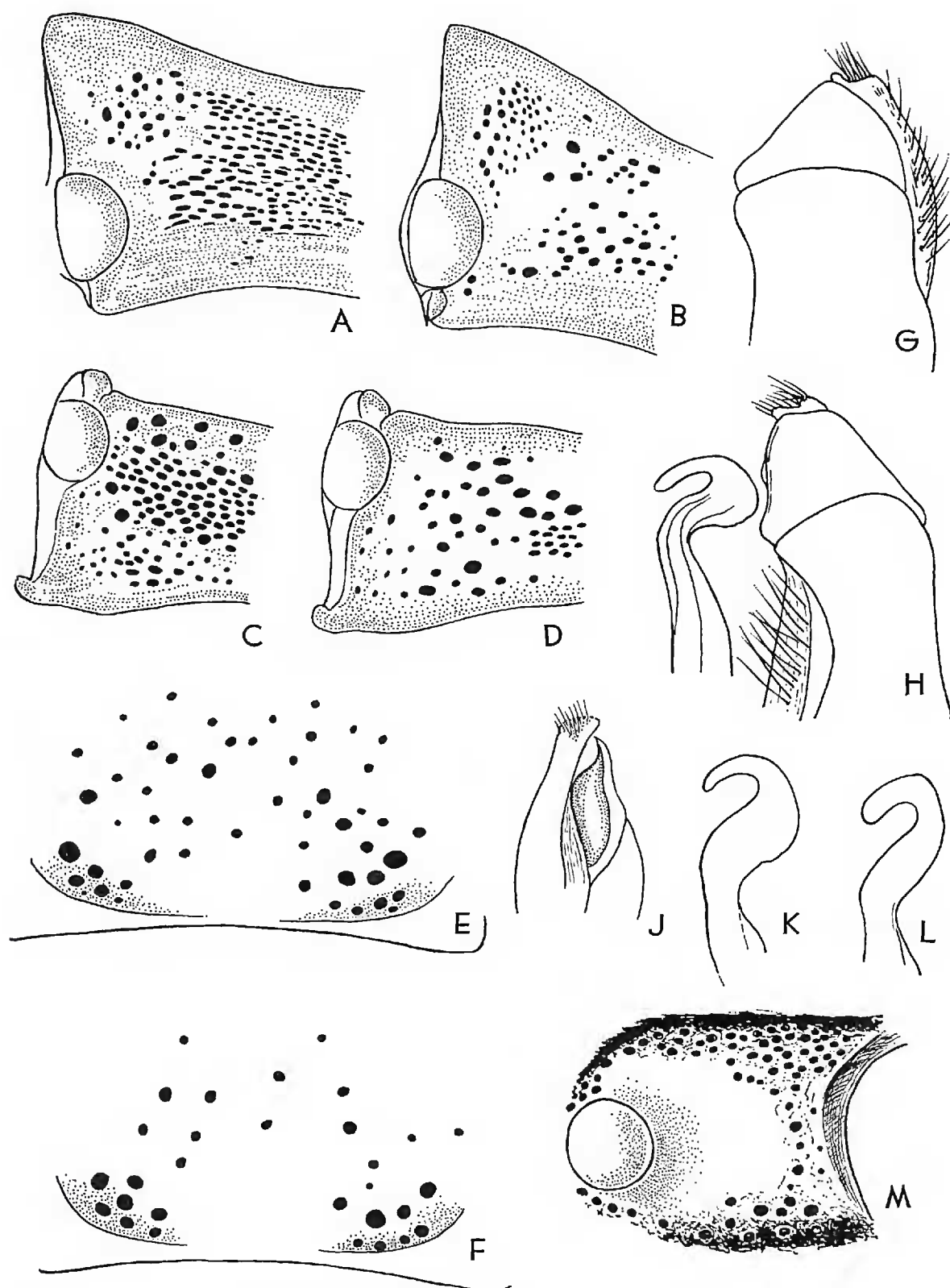


FIG. 8. Comparison of *B. flavus* (A,C,E,G,H,J,K,M) and *B. beaticola* (B,D,F,L). A,B. Base of right mandible (queen); C,D. Base of left mandible (worker); E, F. Punctuation on lower part of worker clypeus; G,H. Apex of male genitalia dorsolateral and dorsal views; J. Inner depression of gonostylus; K,L. Apex of penis valve; M. Sculpture of ocellocular area (queen).

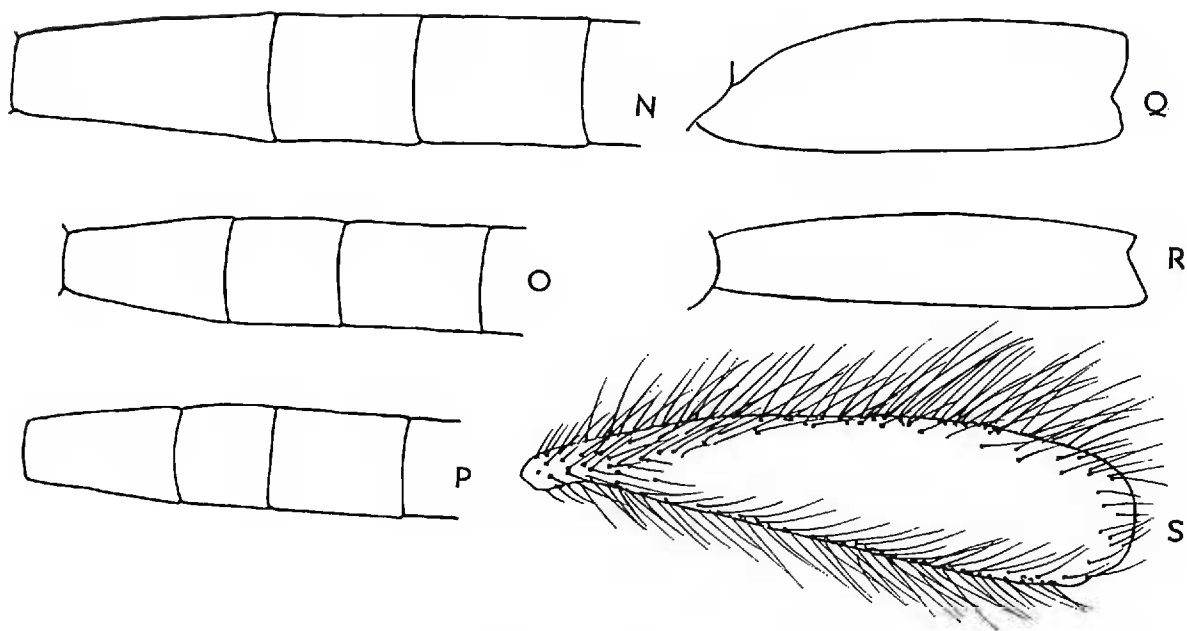


FIG. 9. *Bombus flavus*, continued. N,O,P. Basal flagellar segments (queen, male, worker); Q, R. Male hind and mid basitarsi; S. Male hind tibia.

and dense punctures. Hypopygium weakly ridged but not carinate. Hind tibia shining but microscopically alutaceous except marginally and basally. Mid basitarsus shagreened but shining, posterior margin nearly straight. Hind basitarsus shagreened even basally, though less conspicuously than mid basitarsus, posterior margin gently curved.

WORKER.—Body 11 ~ 13 mm, forewing 9.5 ~ 10.5 mm. *Structure.*—Similar to queen except certain caste-linked reductions of sculpture. *Hair color.*—Head as in queen but short hairs paler, occiput and gena behind with more ochraceous or yellowish long hairs. Other body parts ochraceous to yellow, with admixture of dark brown hairs in variable degrees on mesosomal disc and metasomal terga as shown later; terga IV ~ V often more or less with dull orange tone in parallel with increased admixture of dark hairs on tergum III. Tibiae and tarsi dark brown; corbicular fringes ochraceous with admixture of dark brown hairs, especially posteriorly (Fig. 10d).

MALE.—Body 11 ~ 13 mm, forewing 9.5 ~ 10.5 mm. *Hair color.*—Uniformly pale ochraceous to citron yellow. Mandibular beard orange yellow. Sparse dark brown hairs on vertex, gena, face along inner orbit and mesosomal disc, slightly denser centrally but rather uniformly distributed (Fig. 10d, III). Terga apically slightly paler, with no admixture of dark hairs.

Structure.—Upper, maximum and lower interorbital distances, 30:36:32. Supraorbital area essentially as in females, punctures slightly larger than facets, rather ill-defined though slightly more distinct than in *B. beaticola*; parafacettal corridor only sparsely punctured. Relative measurements on vertex: Ocellocular distance 18, postocellar distance 20, distance between mid and lateral ocelli 5, diameters of mid and lateral ocelli 10, 9. Malar space as in females but punctures finer, length:width as 25:21. Length:width ratios of flagellar segments: I (17:11, basal width 6), II (12:11), III (15:11) (Fig. 90). Median impunctate area of mesoscutum smooth and very narrow, with sparse punctures along median line. Terga as in *B. beaticola*. Hind tibia well corbicated (Fig.

9S), fringes longer than width of segment, upper surface slightly convex basally, flat apically, smooth and shining, slightly shagreened at base and posterior margin; apical bristles exceeding apex. Mid basitarsus (Fig. 9R) shining but shagreened, with hind margin slightly tapering apically. Hind basitarsus (Fig. 9Q) finely shagreened but more shining than mid basitarsus; posterior margin slightly tapering apically. Stipes wider than in *B. beaticola*, curvature of inner margin as in *B. modestus*, not *B. beaticola*, outer apical angle more distinctly curved than in *B. beaticola* (Fig. 8G, H). Penis valve rather parallel sided, apical hook with outer margin distinctly rounded and basally rather widened, tapering apically (Fig. 8H, K, L).

The identification of this species was possible by the courtesy of Dr. B. Tkalců. The original description is very short, only, "Asia centr., einfarbig gelb behaart." The males are structurally identical to the type as defined by a note and pencil sketches which Dr. Tkalců made from the type, and sent to me years ago for a different purpose, and by another more detailed note sent by him according to my request. The unique difference is the presence of sparse dark hairs in my specimens, which could be interpreted as an extreme of variation range. According to Dr. Tkalců, the specimen which he labelled as lectotype as preserved in the collection of the Zoologisches Museum der Humboldt Universität Berlins, with the following four labels: 1) Turkestan Kashgar 22. 7. 1900. 2) *Bombus pratorum* v. *flavus* Fr. ♂ 1904 Friese det. 3) *Bombus pratorum* v. *flavus* Fr. 4) Red label printed "type." The genitalia is separately pinned with a label as in 2) shown above. Dr. Tkalců informed me that the locality was false, the real locality being probably Szechuan or adjacent territories (cf. Tkalců, 1968a, p. 49, footnote). He also examined another nearly identical specimen from Tien-mu-shan, China. Meanwhile, a single queen examined by me agrees well with the description of *B. klapperichi* Pittioni described from Fukien Province both in coloration and structure, except for: 1) Smaller size (17 ~ 18 mm in *B. klapperichi*). 2) Inner orbits slightly convergent below (parallel in *B. klapperichi*). 3) Distance between mid and lateral ocelli slightly longer (ratio to diameter of lateral ocellus 12:6 in *B. flavus*, 12: > 6 in *B. klapperichi*). 4) Flagellum I $2w > 1$ in *B. flavus* $2w = \text{ca.} 1$ in *B. klapperichi*. These differences are regarded as lying within the variation range and 2) and 3) could be interpreted as an outcome of allometric change as shown in *B. trifasciatus*. Further the worker coloration is variable but approximately corresponds to *B. f. flavescensformis*. Consequently it is concluded that *B. flavus*, so far known from the male alone, is conspecific with *B. klapperichi*, known only from

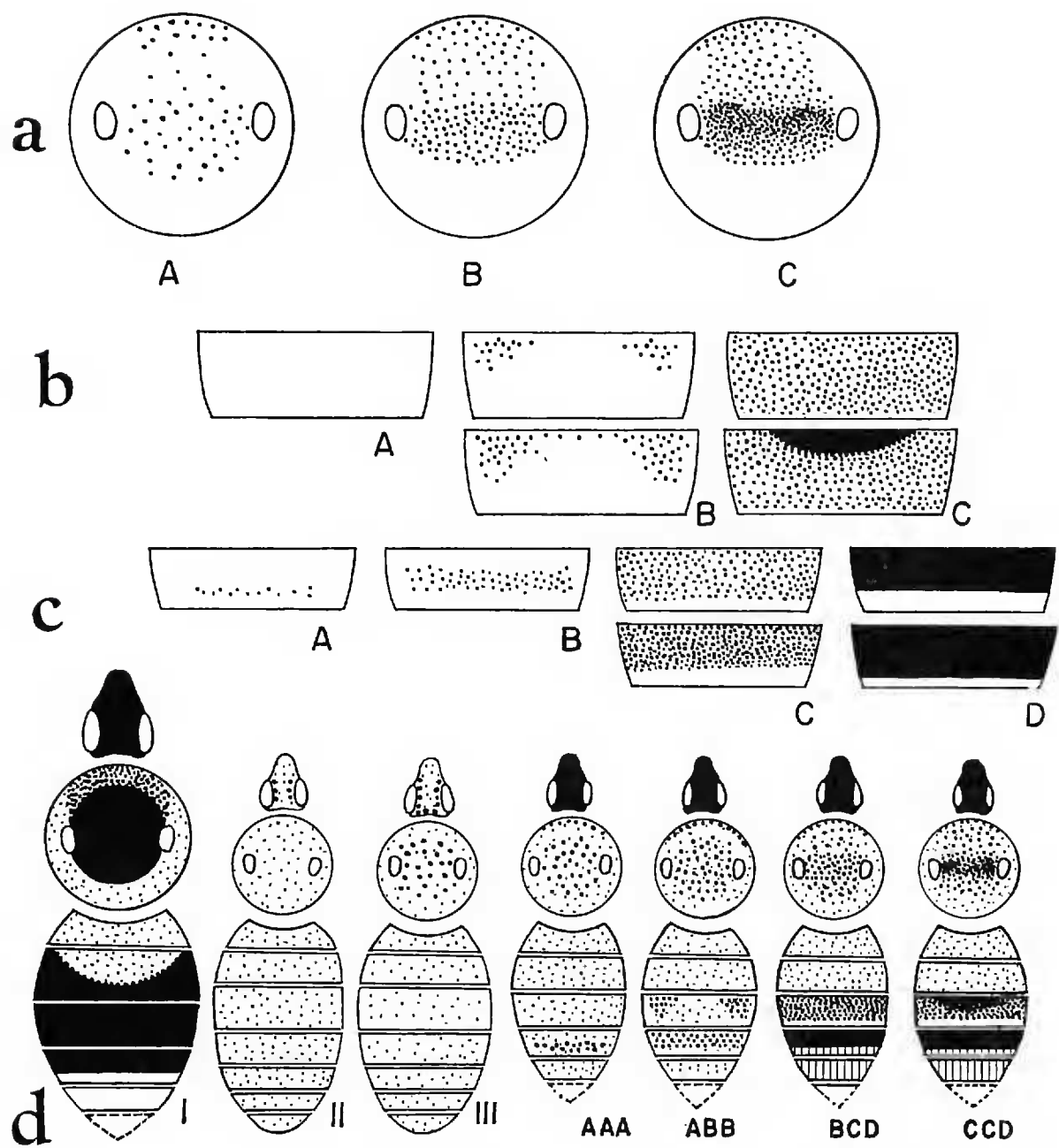


FIG. 10. Color variation in *B. flavus*. a. Mesosomal dorsum; b,c. Metasomal terga III and IV; d. Selected color patterns. I. Queen, II. Male type specimens (from note by Dr. Tkalců), III. Male recorded in text; Other showing representative patterns in worker.

the female, and the species has a wide distribution from Kwangtung to Szechuan, probably throughout Central and Southern parts of China, forming a southern and continental vicariant of *B. modestus* in Siberia and *B. beaticola* in Japan. Comparing with the synoptic table of the latter two species by Tkalců (1968a, p. 33), *B. flavus* is closer to *B. modestus* in relative lengths of flagellar segments and shape of stipes, but closer to *B. beaticola* in the less shagreened hind basitarsus.

In coloration the queen is comparable to *B. beaticola moshkareppus* Sakagami et Ishikawa from Hokkaido, Northern Japan, by the

prevalence of dark hairs on the face and mesosomal disc, but the pleura are broadly pale as in *B. b. beaticola* (Tkalců) from Central Japan (Sakagami and Ishikawa, 1969). The variation in workers is mainly caused by the degree of admixture of dark hairs on the mesosomal disc and metasomal terga III and IV, which positively correlates with an increase of dark hairs on head and corbicular fringes, as well as intensified orange tone on apical terga. The variability in mesosomal disc and metasomal terga III and IV, shown in Fig. 10a ~ c, results in various types of combinations, the frequency distribution of which in the specimens in good condition is: AAA (6 specimens), ABA (2), BAA (1), AAB (2), ABC (1), ABD (1), BCD (4), CCD (5), showing the presence of two dominant types, a paler type (AAA) and a queen like type (BCD, CCD). Thus the variation trend is precisely similar to that of *B. beaticola* (Sakagami and Ishikawa, 1969).

PSITHYRUS (METAPSITHYRUS) PIELI Maa

Psithyrus (Metapsithyrus) pieli Maa, 1948: 29, ♂, ♀.

SPECIMENS EXAMINED.—LK, 9 September, 1♀, 1♂.

Dr. B. Tkalců suggested this possible identification. Both specimens were in poor condition.

DISCUSSION

Excluding *Psithyrus* and the specimens collected in Luichow Peninsula, Kwangtung Province, all specimens examined are tabulated according to relative abundance and seasonal distribution as follows:

| | Number of specimens (♀ - ♂ - ♂) | | | | | | | | |
|------------------------|-----------------------------------|--------|--------|--------|-----------|--------|-------|---------|-----|
| | July | August | | | September | | | Total | |
| | late | early | mid | late | early | mid | late | (444) | |
| <i>B. trifasciatus</i> | 0-25-0 | 0-27-0 | 0-77-1 | 0-83-0 | 0-88-3 | 0-23-3 | 0-7-1 | 0-330-7 | 337 |
| <i>B. imitator</i> | 0-2-0 | 0-1-0 | 0-1-1 | 0-11-3 | 0-1-1 | 0-8-3 | | 0-27-8 | 35 |
| <i>B. flavus</i> | | 0-2-0 | 0-6-0 | 0-7-2 | 1-5-2 | 0-1-0 | 0-1-0 | 1-24-4 | 29 |
| <i>B. pyrosoma</i> | 0-2-0 | 0-1-0 | | | 0-9-1 | 0-1-0 | 0-1-0 | 0-14-1 | 15 |
| <i>B. ignitus</i> | | 0-5-0 | 0-3-0 | | 0-1-0 | 0-3-0 | | 0-12-0 | 12 |
| <i>B. atripes</i> | | | | | | 0-2-1 | 0-3-0 | 0-5-1 | 6 |
| <i>B. breviceps</i> | | | | | | | 0-2-1 | 0-2-1 | 3 |
| <i>B. opulentus</i> | | | | | | 0-0-1 | 0-1-1 | 0-1-2 | 3 |
| <i>B. kulingensis</i> | | | | 1-2-0 | | | | 0-2-0 | 3 |
| <i>B. flavescens</i> | | 0-0-1 | | | | | | 0-0-1 | 1 |

The relative abundance is strongly influenced by the overwhelming predominance of *B. trifasciatus* (75.5 % of all specimens), followed

by *B. imitator* (7.8 %) and *B. flavus* (6.5 %). Although the collecting was limited to late summer to early fall, the relative abundance may reflect the quantitative makeup of the local fauna because of the long annual cycle of most bumble bees. Exceptions are expected in *Pyrobombus*. It is likely that some short-cycle species of this subgenus were not collected. The capture of males of *B. flavus* in late August and early September suggests that this species possesses a life cycle relatively longer than other *Pyrobombus*. But the capture records of males of an allied species, *B. beaticola* in Japan (Honshu, records at altitudes less than 2,000 m) show a remarkable variation: late May (1), late June (1), early July (1), mid July (12), late July (18), early August (18), late August (6), early September (17), mid September (2). Recently Meidell (1968) asserts that *Bombus* (*Pyrobombus*) *jonellus* (Kirby) possesses two generations per year in Norway. Naturally such opinion cannot uncritically be generalized to other species showing a wide variation of male appearance. But it is interesting to pursue this problem in various species of *Pyrobombus*, many of which are characterized by an ephemeral colony life which can be studied in part by checking the records of preserved specimens.

It is still premature to discuss the zoogeographical position of the bumble bee fauna of the area considered, which belongs, in the system by Panfilov (1957), to the Central Chinese Province in the Japan-China-Himalayan Subregion. He comments that the few studies in this province indicate only *B. atripes*, *B. (Adventribombus) unicolor* Friese and *B. (Hortobombus) supremus* F. Morawitz as typical of the area. Most species examined by me are those endemic to China Proper including: *B. trifasciatus*, *B. atripes*, *B. imitator*, *B. opulentus*, *B. flavus*, *B. pyrosoma*, *B. kulingensis* and *P. pieli*. One species, *B. ignitus*, reaches Japan and two, *B. breviceps* and *B. flavescens* South East Asia. On the other hand, no Euro-Siberian elements in the broadest sense are recognized, though some species are regarded "secondarily" as belonging to northern groups (*B. flavus* and *B. opulentus*).

Among the bumble bees studied, there is no instance of strict sympatric isochromy as recorded in South East Asia (e.g. Tkalců 1968c). The patterns recognized in the area studied are divided as follows:

- 1) Pale mesosoma with dark interalaris and trichromatic (pale, dark, reddish) metasoma. To this pattern belong the following

species with deviations from the model as given parenthetically: *B. trifasciatus* (♀, ♂, ♂. Interalaris often expanded), *B. kulingensis* (♀, ♂, ♂ unknown. Interalaris expanded), *B. flavus* (♀ and some ♂), *B. imitator* (♀, ♂, ♂. Interalaris often weakened). *B. ignitus* (♂, though not collected), *B. breviceps* (♀, ♂, ♂. Pale hairs distinctly darker), *B. pyrosoma* (♂, ♂. Considerably deviated from the model by weakening of interalaris, absence of dark metasomal band and in workers pale hairs nearly whitish).

2) Black with red tail. Widespread in the Palaearctics, isolately appearing in some Andean species. *B. ignitus* (♀, ♂), *B. flavescens* (partly).

3) Predominantly pale. *B. flavus* (♂, some ♂), *B. flavescens* (partly, though not captured from the area).

4) Bright orange fore body with dark venter, with or without dark apical terga. *B. opulentus*, *B. atripes*.

From this tabulation, it is easily recognized that the first mentioned pattern prevails in the area studied.

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